Environmental Product Declaration

Environmental Product Declaration for cement produced by Holcim Ecuador at their plant in Guayaquil, Ecuador

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ADMINISTRATIVE INFORMATION

International Certified Environmental Product Declaration

Declared Product:	This Environmental Product Declaration (EPD) covers cement products produced by Holcim Ecuador. Declared unit: 1 tonne of cement
Declaration Owner:	**Holcim Ecuador** 444 S/N Av. Barcelona y José Rodriguez Bonin, Edif. El Caimán Piso 2, Guayaquil holcim.com.ec
Program Operator:	Labeling Sustainability 11670 W Sunset Blvd. Los Angeles, CA http://labelinsustainability.com/
Product Category Rule:	Core PCR: ISO 21930:2017 Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services SubPCR: NSF International (March2020). Product Category Rules (PCR) for ISO 14025 Type III Environmental Product Declarations (EPD) of Portland, Blended, Mansory, Mortar and Plastic (stucco) Cements, Valid through March 31, 2025. Sub PCR Program Operator: NSF International Sub-category PCR review was conducted by: Thomas P. Gloria, Ph. D. of Industrial Ecology Consultants: 35 Bracebridge, Rd., Newton, MA 02459-1728, t.gloria@industrial-ecology.com. Mr. Bill Stough, Sustainable Research Group: PO Box 1684, Grand Rapids, MI 49501-1684, bstough@sustainableresearchgroup.com. Mr. Jack Geilbig, EcoForm: 2624 Abelia War, Suite 611, Knoxville, TN 37931, jgeilbig@ecoform.com
Independent LCA Reviewer and EPD Verifier:	This EPD was independently verified in accordance with ISO 14025. The life cycle assessment was independently reviewed in accordance ISO 14044 and the referenced PCR. Independent verification of the declaration, according to ISO 14025:2006 Internal ☐ ; External X Third Party Verifier Geoffrey Guest, Certified 3rd Party Verifier under the CSA group (www.csaregistries.ca), Labeling Sustainability (www.labelingsustainability.com), P3Optima (www.P3Optima.com)
Date of Issue:	29 November 2022
Period of Validity:	5 years; valid until 30 November 2027
EPD Number:	e717da92-6ee-4fdb-b7d3-acfac1d3df01

COMPANY DESCRIPTION

Holcim Ecuador is part of the international Holcim group, a leader in innovative and sustainable construction solutions. With more than 100 years of experience in the country producing cement, concrete, aggregates, and solutions for the construction market. As well as its subsidiary company, Geocycle reinforces the commitment to the circular economy through the co-processing of waste. Holcim Ecuador has extensive coverage in the national territory, with an integrated cement plant in Guayaquil, a cement grinding plant in Latacunga, eleven concrete plants in Guayaquil, Quito, Cuenca, Manabí, Machala, Quevedo and Ambato, mobile equipment concrete, 2 aggregate plants in Pifo and Daule, the latter being Loma Alta, the first plant with 52% women in its operations.

Per EPD guidelines, carbon credits in any form are not allowed to be part of the calculations. For the Cement Maestro and Base Vial (MH) Holcim Ecuador offsets 100% of their carbon emissions through forestry offsets. The emissions generated by Holcim Maestro and Base Vial cements are being offset in the Cerro Blanco Protected Forest, which is in Guayaquil - Salinas Km 16, Chongón Parish, Guayaquil Canton, Guayas Province. At X coordinates 609389.32 and Y 9758626.22. Holcim manage 6,072 hectares of native forest, annually the company supports financially to carry out conservation actions.

The forest contains a very wide biodiversity, it has more than 700 species of plants of which 20% are endemic to southwestern Ecuador, 75 species of mammals including the jaguar, howler monkeys and bats, 221 species of birds, 8 amphibian species, among others. (White Hill 2020). The data obtained indicate that the forest is capturing an average of 2.85 Ton CO_2/ha/year. Which has a typical or standard error of 0.12%. The coefficient of variation is 23.10% and with a sampling error it is 6.93%.

Maestro and Base Vial (MH) cements are offset with these credits if reporting outside of the EPD. The PCRs used in this study do not allow for offset credits to be used in the calculation of a product's Global Warming Potential (GWP).

STUDY GOAL

The intended application of this life cycle assessment (LCA) is to comply with the procedures for creating a Type III environmental product declaration (EPD) and publish the EPD for public review on the website, http://labelingsustainability.com/ . This level of study is in accordance with EPD Product Category Rule (PCR) for Cement published by NSF (2020) and is a PCR in accordance with ISO 21930 for Preparing an Environmental Product Declaration for Portland, Blended Hydraulic, Masonry, Mortar, and Plastic (Stucco) Cements. EPDs for cements that follow other PCRs may not be comparable.; International Standards Organization (ISO) 14025:2006 Environmental labels and declarations, Type III environmental declarations-Principles and procedures; ISO 14044:2006 Environmental management, Life cycle assessment- Requirements and guidelines; and ISO 14040:2006 Environmental management, Life cycle assessment-Principles and framework. The performance of this study and its subsequent publishing is in alignment with the business-to-business (B2B) communication requirements for the environmental assessment of building products. The study does not intend to support comparative assertions and is intended to be disclosed to the public.

This project report was commissioned to differentiate Holcim Ecuador from their competition for the following reasons: generate an advantage for the organization; offer customers information to help them make informed product decisions; improve the environmental performance of Holcim Ecuador by continuously measuring, controlling and reducing the environmental impacts of their products; help project facilitators working on Leadership in Energy and Environmental Design (LEED) projects achieve their credit goal; and to strengthen Holcim Ecuador's license to operate in the community. The intended audience for this LCA report is Holcim Ecuador's employees, their suppliers, project specifiers of their products, architects, and engineers. The EPD report is also available for policy makers, government officials interested in sustainability, academic professors, and LCA professionals. This LCA report does not include product comparisons from other facilities.

DESCRIPTION OF PRODUCT AND SCOPE

This EPD is prepared for products classified as UN CPC Group 3744-Cement or CSI MasterFormat Division 03 30 00 Cast-in-Place Concrete.

This EPD is primary reported Holcim data from the reference year 2021. It reports on the six cement mixes produced at the Guayaquil cement plant, made from primarily limestone. These six cement mixes make up 100% of yearly production at the Guayaquil cement plant. Cement from the Guayaquil cement plant is used in the EPDs for concrete mixes in Ecuador concrete plants. This plant is not a grinding operation.

This LCA assumes the impacts from products manufactured in accordance with the standards outlined in this report. This LCA is a cradle-to-gate study, and therefore, stages extending beyond the plant gate are not included in this LCA. Excluded stages include transportation of the manufactured material to the construction site; on-site construction processes and components; building (infrastructure) use and maintenance; and "end-of-life" effects.

CEMENT DESIGN SUMMARY

The following tables provide a list of the cement products considered in this EPD along with key performance parameters.

Table 1: **Declared products with All declared products considered in this environmental product declaration**

Mix#	Unique name/ID	Short description	Clinker content, wt%	Resistance @28 Days (MPa)
1	GU Cement	Hydraulic Cement with specified strength at 3 days	Proprietary	30
2	HE Cement	High strength hydraulic cement with specified strength at 1 day	Proprietary	42
3	MH Cement	Hydraulic cement with moderate heat of hydration with specified strength at 3 days	Proprietary	22

4	HE/HS Cement	Hydraulic cement with high resistance to sulfates with specified strength at 1 day	78.92	32
5	Maestro Cement	Non-structural cement with specified strength at 7 days	37.42	9
6	Cement with Slag	Cement with blast furnace slag specified strength at 3 days	32.63	27
7	Clinker for export	Clinker to export	100.00	n/a

CEMENT DESIGN COMPOSITION

The following figures provide mass breakdown (kg per functional unit) of the material composition of each cement design considered. Please note that the breakdown has been randomly altered and is therefore only an approximation; this manipulation is to ensure confidentiality.

Table 2 **Cement composition**

Product Components	Raw Material, weight%
Clinker	Proprietary
Mineral Additions (limestone and Pozzolana)	30-60.00
Others	0.01-5.00
Total	100.00

SYSTEM BOUNDARIES

The following figure depicts the cradle-to-gate system boundary considered in this study (ND= Not Defined)

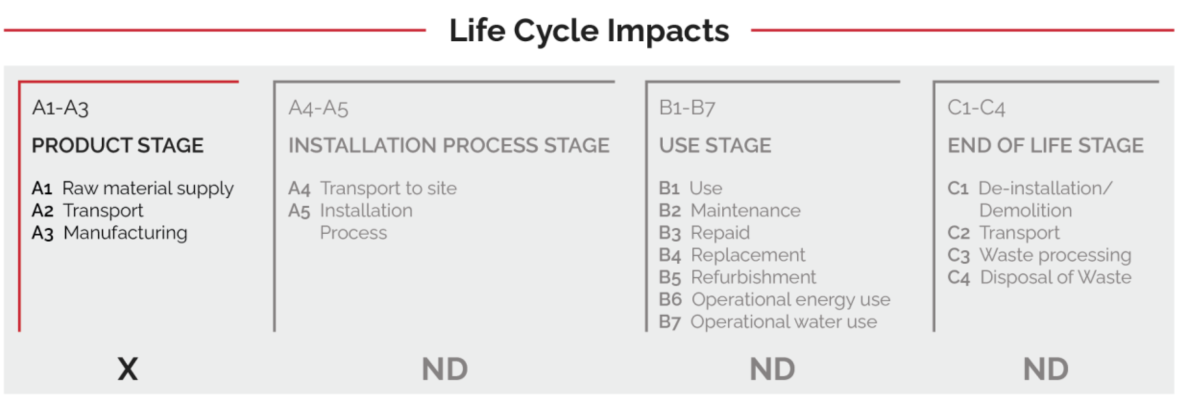

Figure 2: **General life cycle phases for consideration in a construction works system**

This is a Cradle-to-gate life cycle assessment and the following life cycle stages are included in the study:

- A1: Raw material supply (upstream processes) - Extraction, handling, and processing of the materials used in manufacturing the declared products in this LCA.
- A2: Transportation - Transportation of A1 materials from the supplier to the "gate" of the manufacturing facility (i.e., A3).
- A3: Manufacturing (core processes)- The energy and other utility inputs used to store, move, and manufacturer the declared products and to operate the facility.

As according to the PCR, the following figure illustrates the general activities and input requirements for producing cement products and is not necessarily exhaustive.

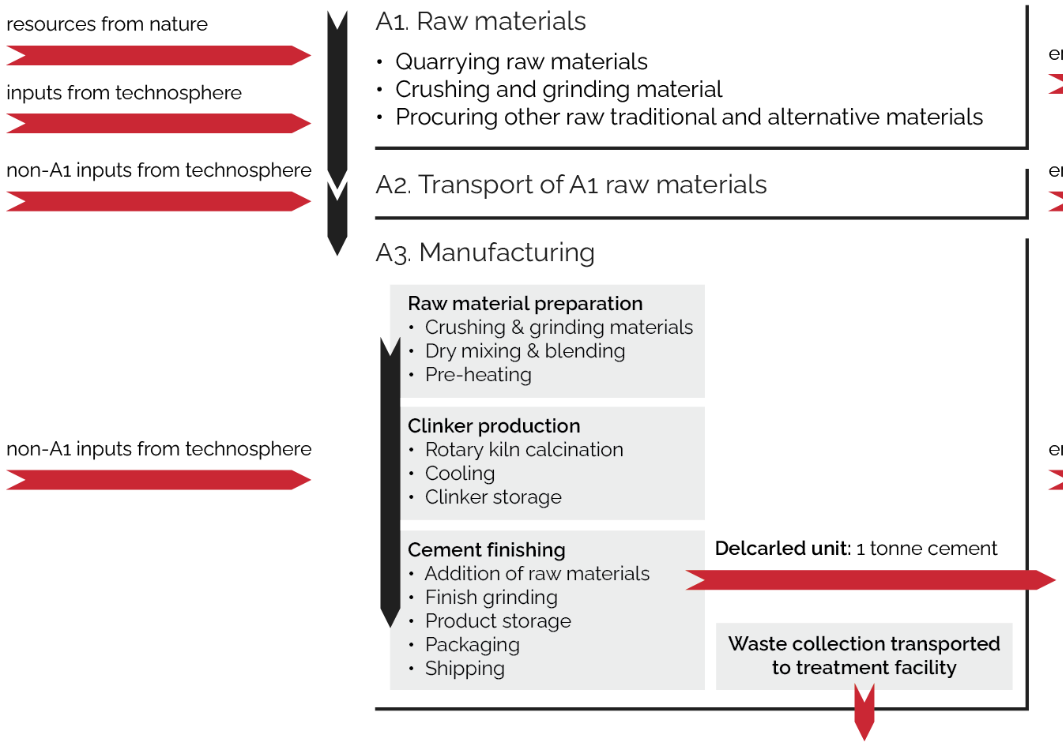

Figure 3: **General system inputs considered in the product system and categorized by modules in scope**

In addition, as according to the relevant PCR, the following requirements are excluded from this study:

- Production, manufacture and construction of A3 building/capital goods and infrastructure;
- Production and manufacture of steel production equipment, steel delivery vehicles, earthmoving equipment, and laboratory equipment;
- Personnel-related activities (travel, furniture, office supplies);
- Energy use related to company management and sales activities.

For this LCA the manufacturing plant, owned and operated by Holcim Ecuador, is located at their Guayaquil Cement Plant facility in Ecuador. All operating data is formulated using the actual data from Holcim Ecuador's plant at the above location, including water, energy consumption and waste generation. All inputs for this system boundary are calculated for the plant.

This life cycle inventory was organized in a spreadsheet and was then input into an RStudio environment where pre-calculated LCIA results for relevant products/activities stemming from the ecoinvent v3.6 database and a local EPD database in combination with primary data from Holcim Ecuador were utilized. Explanations of the contribution of each data source to this study are outlined in the section 'Data Sources and Quality'.

CUT-OFF CRITERIA

ISO 14044:2006 and the focus PCR requires the LCA model to contain a minimum of 95% of the total inflows (mass and energy) to the upstream and core modules be included in this study. The cut-off criteria were applied to all other processes unless otherwise noted above as follows. A 1% cut-off is considered for all renewable and non-renewable primary energy consumption and the total mass of inputs within a unit process where the total of the neglected inputs does not exceed 5%.

DATA SOURCES AND DATA QUALITY ASSESSMENT

Raw material transport: A combination of actual mode/distance combinations were assumed for key bulk materials whereas ecoinvent default multi-modal market mix distances were assumed for other inputs where no original data could be provided.

Electricity: Electricity consumption values are for Holcim Ecuador in calendar year 2021. These values were direct reported from Holcim Ecuador records. The unit process "market for electricity, medium voltage/electricity, medium voltage/EC/kWh" was used to represent the Ecuador grid electricity used by the Guayaquil cement plant. Ecuador uses hydropower for 93% of their electricity.

Process/space heating: Not applicable

Fuel required for machinery: Machinery-related fuel requirements were determined from direct Holcim information for fuel use outside the kiln. LPG is used for moving vehicles for raw materials. Direct emission calculations for propane were calculated with ecoinvent 3.8-unit processes normalized to the amount of fuel used per ton of cement.

Waste generation: Waste generation values are directly reported from Holcim operations for both bulk waste and hazardous waste. No High-level radioactive waste is generated on-site at this facility

Recovered energy: Not applicable

Recycled/reused material/components: Any recycled or reused materials are detailed in the A1 input table.

Module A1 material losses: Due to lack of data, default loss factors were assumed; A broad 2% waste factor was used throughout this study.

Direct A3 emissions accounting: Holcim Ecuador does not report their direct emissions therefore the only Holcim calculation used for emissions was the decarbonization of the clinker at the kiln. All other emissions, both the kiln emissions ad outside the kiln, were modeled using ecoinvent unit processes.

Waste transport requirements: Due to lack of data, default loss factors were assumed. Market transportation was chosen to represent the removal of waste from the plant. The actual destination is not always known therefore exact numbers could not be used.

The following tables depict a list of assumed life cycle inventory utilized in the LCA modeling to generate the impact results across the life cycle modules in scope. An assessment of the quality of each LCI activities utilized from various sources is also provided.

Table 3: **LCI inputs assumed for module A1 (i.e. raw material supply)**

Input	LCI.activity	Data.source	Geo	Year	Technology	Time	Geography	Reliability	Completeness
Additives	market for chemical, inorganic/chemical, inorganic/GLO/kg	ecoinvent v3.8	Multiple Regions	v3.8 in 2021	2	3	1	3	3
Coke (to make Clinker Batch Type I)	petroleum coke production, petroleum refinery operation/petroleum coke/RoW/kg	ecoinvent v3.8	Multiple Regions	v3.8 in 2021	2	3	1	3	3
Diesel (to make Clinker Batch Type I)	market for diesel/diesel/RoW/kg	ecoinvent v3.8	Guayas	v3.8 in 2021	2	3	2	3	3
Iron ore (to make Clinker Batch Type I)	iron ore mine operation, 63% Fe/iron ore, crude ore, 63% Fe/IN/kg	ecoinvent v3.8	Pichincha	v3.8 in 2021	2	3	1	3	3
Limestone (to make Clinker Batch Type I)	limestone production, crushed, for mill/limestone, crushed, for mill/RoW/kg; Note: modifications made (see ecoinvent activity changes table)	ecoinvent v3.8	Guayas	v3.8 in 2021	2	3	1	3	3
Coal (to make Clinker Batch Type I)	market for hard coal/hard coal/RoW/kg	ecoinvent v3.8	Lousiana	v3.8 in 2021	2	3	1	3	3

Clay 1 (to make Clinker Batch Type I)	clay pit operation/clay/RoW/kg	ecoinvent v3.8	Guayas	v3.8 in 2021	2	3	1	3	3
Gypsum	gypsum quarry operation/gypsum, mineral/RoW/kg	ecoinvent v3.8	Multiple Regions	v3.8 in 2021	2	3	1	3	3
Pozzolana (to make Clinker Batch Type I)	calcareous marl production/calcareous marl/RoW/kg	ecoinvent v3.8	Cotopaxi	v3.8 in 2021	2	3	1	3	3
Hard coal ash (to make Clinker Batch Type I)	Waste input produced off-site	See A3 inputs	Guayas	See A3 inputs	2	A3	1	A3	A3

DATA QUALITY ASSESSMENT

Data quality/variability requirements, as specified in the PCR, are applied. This section describes the achieved data quality relative to the ISO 14044:2006 requirements. Data quality is judged based on its precision (measured, calculated, or estimated), completeness (e.g., unreported emissions), consistency (degree of uniformity of the methodology applied within a study serving as a data source) and representativeness (geographical, temporal, and technological).

Precision: Through measurement and calculation, the manufacturers collected and provided primary data on their annual production. For accuracy, the LCA practitioner and 3rd Party Verifier validated the plant gate-to-gate data.

Completeness: All relevant specific processes, including inputs (raw materials, energy, and ancillary materials) and outputs (emissions and production volume) were considered and modeled to represent the specified and declared products. Most relevant background materials and processes were taken from ecoinvent v3.6 LCI datasets where relatively recent region-specific electricity inputs were utilized. The most relevant EPDs requiring key A1 inputs were also utilized where readily available.

Consistency: To ensure consistency, the same modeling structure across the respective product systems was utilized for all inputs, which consisted of raw material inputs and ancillary material, energy flows, water resource inputs, product, and co-products outputs, returned and recovered Cement materials, emissions to air, water and soil, and waste recycling and treatment. The same background LCI datasets from the ecoinvent v3.6 database were used across all product systems. Crosschecks concerning the plausibility of mass and energy flows were continuously conducted. The LCA team conducted mass and energy balances at the plant and selected process level to maintain a high level of consistency.

Reproducibility: Internal reproducibility is possible since the data and the models are stored and available in a machine-readable project file for all foreground and background processes, and in Eco-Purpose's proprietary Cement LCA calculator* for all production facility and product-specific calculations. A considerable level of transparency is provided throughout the detailed LCA report as the specifications and material quantity make-up for the declared products are presented and key primary and secondary LCI data sources are summarized. The provision of more detailed publicly accessible data to allow full external reproducibility was not possible due to reasons of confidentiality.

Label Sustainability has developed a proprietary tool that allows the calculation of PCR-compliant LCA results for Cement product designs. The tool auto-calculates results by scaling base-unit Technosphere inputs (i.e., 1 kg sand, 1 kWh electricity, etc.) to replicate the reference flow conversions that take place in any typical LCA software like openLCA or SimaPro. The tool was tested against several LCAs performed in openLCA and the tool generated identical results to those realized in openLCA across every impact category and inventory metric (where comparisons could be readily made).

Representativeness: The representativeness of the data is summarized as follows.

- Time related coverage of the manufacturing processes' primary collected data from 2020-01-01 to 2020-12-31.
- Upstream (background) LCI data was either the PCR specified default (if applicable) or more appropriate LCI datasets as found in the country-adjusted ecoinvent v3.6 database.
- Geographical coverage for inputs required by the A3 facility(ies) is representative of its region of focus; other upstream and background processes are based on US, North American, or global average data and adjusted to regional electricity mixes when relevant.
- Technological coverage is typical or average and specific to the participating facilities for all primary data.

ENVIRONMENTAL INDICATORS AND INVENTORY METRICS

Per the PCR, this EPD supports the life cycle impact assessment indicators and inventory metrics as listed in the tables below. As specified in the PCR, the most recent US EPA Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), impact categories were utilized as they provide a North American context for the mandatory category indicators to be included in the EPD. Additionally, the PCR requires a set of inventory metrics to be reported with the LCIA indicators (see tables below).

It should be noted that emerging LCA impact categories and inventory items are still under development and can have high levels of uncertainty that preclude international acceptance pending further development. Use caution when interpreting data in any of the following categories.

LIMITATIONS

This EPD is a declaration of potential environmental impact and does not support or provide definitive comparisons of the environmental performance of specific products. Only EPDs prepared from cradle-to-grave life cycle results and based on the same function and reference service life and quantified by the same functional unit can be used to assist purchasers and users in making informed comparisons between products.

LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks. Further, LCA offers a wide array of environmental impact indicators, and this EPD reports a collection of those, as specified by the PCR.

In addition to the impact results, this EPD provides several metrics related to resource consumption and waste generation. While these data may be informational in other ways, they do not provide a measure of impact on the environment.

TOTAL IMPACT SUMMARY

The following table reports the total LCA results for each product produced at the given cement facility on a per 1 tonne of cement basis.

Table 4: **Total life cycle (across modules in scope) impact results for All declared products, assuming the geometric mean point values on a per 1 tonne of cement basis**

a) Midpoint Impact Categories:

Indicator/LCI Metric	AP	EP	GWP	ODP	PCOP	ADPe	ADPf
Unit	**kg SO2eq**	**kg N**	**kg CO2-Eq**	**kg CFC-11.**	**kg O3eq**	**kg Sbeq**	**kg Sbeq**
Maximum	149	0.125	874	2.15e-05	2.1	0.00299	2940
Mean	101	0.0933	568	1.74e-05	1.44	0.00211	2330
GU Cement	85.2	0.0811	529	1.6e-05	1.18	0.00244	2190
HE Cement	100	0.0956	655	1.86e-05	1.45	0.00287	2600
MH Cement	80.7	0.0771	493	1.54e-05	1.11	0.00262	2080
HE/HS Cement	107	0.101	708	1.92e-05	1.56	0.00299	2750
Maestro Cement	65.2	0.0634	362	1.38e-05	0.838	0.00265	1720
Cement with Slag	149	0.125	353	2.15e-05	2.1	0.000851	2020
Clinker for export	119	0.11	874	1.75e-05	1.86	0.000342	2940

b) Inventory Metrics:

Indicator/LCI Metric	TPE	RE	NRE	NRR	RR	WDP	LFW	LFHW	bioC
Unit	**MJ-Eq**	**MJ-Eq**	**MJ-Eq**	**kg**	**kg**	**m3 water-.**	**kg waste**	**kg waste**	**kg**

Maximum	3400	338	3070	125	0.00231	0.738	26.1	0.00255	0.131
Mean	2760	326	2430	93.6	0.00193	0.625	20	0.0022	-0.000829
GU Cement	2620	333	2280	89.5	0.00226	0.712	21	0.00248	-0.0218
HE Cement	3050	333	2720	106	0.00226	0.714	26.1	0.00255	0.0256
MH Cement	2510	336	2170	85	0.00223	0.694	20.5	0.00243	-0.034
HE/HS Cement	3200	334	2880	114	0.00231	0.738	25.4	0.00254	0.0444
Maestro Cement	2130	338	1800	68.3	0.00212	0.67	20.3	0.00254	-0.0848
Cement with Slag	2430	302	2110	67.2	0.000737	0.25	11.6	0.00156	-0.0662
Clinker for export	3400	308	3070	125	0.00158	0.6	15.1	0.0013	0.131

REFERENCES

ASTM Standards:

- ASTM C150/C150M Standard Specification for Portland Cement
- ASTM C260/C260M Standard Specification for Air-Entraining Admixtures for Concrete
- ASTM C595 Standard Specification for Blended Hydraulic Cements
- ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- ASTM C979/C979M Standard Specification for Pigments for Integrally Colored Concrete
- ASTM C989/C989M Standard Specification for Slag Cement for Use in Concrete and Mortars
- ASTM C1017/C1017M Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- ASTM C1116/C1116M Standard Specification for Fiber-Reinforced Concrete
- ASTM C1157/C1157M Standard Performance Specification for Hydraulic Cement
- ASTM C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures
- ASTM C1602/C1602M Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- ASTM G109 Standard Test Method for Determining Effects of Chemical Admixtures on Corrosion of Embedded Steel Reinforcement in Concrete Exposed to Chloride Environments

CSA Standards:

- CAN/CSA A3000 Cementitious Materials Compendium

- CAN/CSA G40.20/G40.21 General requirements for rolled or welded structural quality steel / Structural quality steel

ISO Standards:

- ISO 6707-1: 2014 Buildings and Civil Engineering Works - Vocabulary - Part 1: General Terms
- ISO 14021:1999 Environmental Labels and Declarations - Self-declared Environmental Claims (Type II Environmental Labeling)
- ISO 14025:2006 Environmental Labels and Declarations - Type III Environmental Declarations - Principles and Procedures
- ISO 14040:2006 Environmental Management - Life Cycle Assessment - Principles and Framework
- ISO 14044:2006 Environmental Management - Life Cycle Assessment - Requirements and Guidelines
- ISO 14067:2018 Greenhouse Gases - Carbon Footprint of Products - Requirements and Guidelines for Quantification
- ISO 14050:2009 Environmental Management - Vocabulary
- ISO 21930:2017 Sustainability in Building Construction - Environmental Declaration of Building Products

EN Standards:

- EN 16757 Sustainability of construction works - Environmental product declarations - Product Category Rules for concrete and concrete elements
- EN 15804 Sustainability of construction works - Environmental product declarations - Core rules for the product category of construction products

Other References:

- US EPA Waste Reduction Model (WARM), Fly Ash Chapter: http://epa.gov/climatechange/wycd/waste/downloads/fly-ash-chapter10-28-10.pdf
- USGBC LEED v4 for Building Design and Construction, 11 Jan 2019 available at https://www.usgbc.org/resources/pcr-committee-process-resources-part-b
- USGBC PCR Committee Process & Resources: Part B, USGBC, 7 July 2017 available at https://www.usgbc.org/resources/pcr-committee-process-resources-part-b.